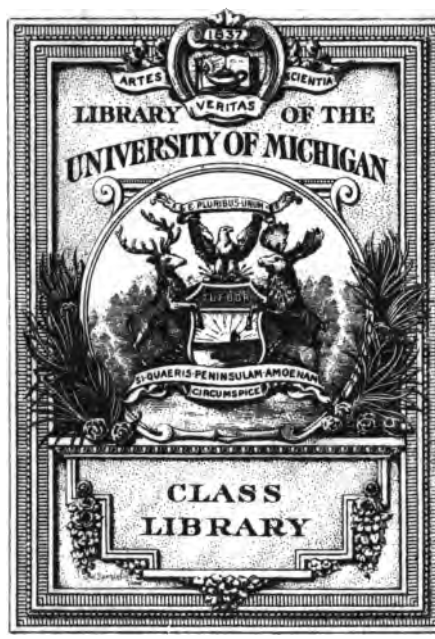
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BULLETIN No. 21. S. P. I. No. 1.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF FORESTRY.

SYSTEMATIC PLANT INTRODUCTION:

ITS PURPOSES AND METHODS.

BY

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PREPARED UNDER THE DIRECTION OF B. E. FERNOW, CHIEF OF THE DIVISION OF FORESTRY.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY,
Washington, D. C., June 28, 1898.

SIR: I have the honor to submit herewith for publication a bulletin on Systematic Plant Introduction, prepared by Mr. David G. Fairchild, agent of the Division of Forestry.

When it was your desire to have the available material for forest plantations in the arid and subarid regions increased by importations from foreign countries I had the honor to submit a plan by which these importations could be systematically undertaken with an expectation of success.

This plan contemplated the employment of a competent special agent who should study the varying climatic conditions of our country as well as of other countries, and then travel over the latter studying their flora of trees and shrubs, and finally secure plant material to be assembled in a number of arboreta established in the various sections of our arid regions and tested for its adaptability before using it in the field at large.

It was expected that in this way, within a few years at least, the basis for finding the most suitable plant material might be laid in a unique collection of all the arid-region plants.

Mr. Fairchild, then traveling in Australia and the Pacific islands, who by his studies at home and in foreign countries was peculiarly fitted for the task, was appointed to carry out this plan. It was, however, soon recognized that the same systematic methods of plant introduction were desirable and applicable in the case of all importations of exotic plants, and Mr. Fairchild's activity was soon broadened to comprise the entire field of importations. In fact, the importations from Russia, which had been made before a systematic plan had been matured, required Mr. Fairchild's full attention at once; the original plan, which contemplated only material for forest purposes, sank into the background, and Mr. Fairchild is now about to discontinue his connection with this Division to assume the wider functions.

The present bulletin, an introductory to this wider field of plant importation, has nevertheless been prepared as from the Division of Forestry, since it discusses the general considerations which should guide in an attempt at plant introduction, and which, in part at least, have also a bearing on the acclimatization of forest-planting material.

Respectfully,

B. E. FERNOW,
Chief of Division.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SYSTEMATIC PLANT INTRODUCTION.

INTRODUCTION.

With the settlement of a new country is inseparably connected the introduction of new plants. This work, which began in America, as W. A. Taylor,* of the U. S. Department of Agriculture, has pointed out, with the efforts of the first settlers scarcely two weeks after their arrival on the island of Jamestown, has been carried on so naturally and gradually that at the present time few people realize the important rôle it has played. Their attention must be called to the fact that of all the food plants now grown in America only the pumpkin and a few grapes, plums, and berries are natives of this country. Even the Indian corn, popularly supposed to be indigenous to the United States, is in all probability an introduction from Mexico.

According to the researches of F. Hock,† a German investigator, cultivated oats, barley, and rye have originated from wild forms growing along the Mediterranean; the varieties of wheat have developed from a wild species in Persia; buckwheat is undoubtedly of Siberian or Manchurian origin; the garden bean (*Phaseolus vulgaris*) flourished in a wild state upon the slopes of the Andes; the parentage of our cultivated cabbage, lettuce, spinach, asparagus, celery, and most root crops can be traced to the Mediterranean; the Orient has undoubtedly furnished civilization with the onion, horse-radish, cucumber, and melon; Peru has given it the Irish and sweet potatoes, eggplant, and tomato; central Asia, the rhubarb; while our apples, quinces, pears, currants, gooseberries, and California grapes are of European parentage, and our strawberries have resulted from crossing the native with a Chilean species.

While the development of the indigenous fruits of this country has been attended with marked success, it is a noteworthy fact that the Old World civilization has profited but little through the discovery of new food plants in North America.

The rapid development of any new country is due to the discovery of soil and climatic conditions suited to the growth of introduced food plants, and seldom to the development of an endemic species. California owes its wealth and phenomenal development to conditions favor-

* Taylor, William A. The Fruit Industry and Substitution of Domestic for Foreign-Grown Fruits. Yearbook U. S. Department of Agriculture, 1897, p. 308.

† Hock, F. Nahrpflanzen Mitteleuropas, ihre Heimat, Einführung in das Gebiet und Verbreitung innerhalb desselben; Stuttgart, J. Engelhorn, 1890, pp. 67.

able to the cultivation of the European grape and the orange. Australia is largely dependent upon her fields of grain and her growing fruit trade. Her native food plants play no important part in her development. The wealth of Ceylon and Java is reaped largely from the cultivation of five or more exotic species, the Chinese and Assam teas, the Peruvian cinchona, and the Arabian and Liberian coffees. South African civilization, from an agricultural standpoint, is not causally connected with the development of any native plant product. So thoroughly has this fact been recognized by all colonizing nations that they have established botanic gardens in their new colonies, one important function of which is to secure and distribute exotic economic plants throughout the colony.

Such work of introduction has been carried on by the Department of Agriculture for many years, and though it is not within the province of this bulletin to point out the benefits accruing from the introductions made, notably by Mr. William Saunders, Chief of the Division of Gardens and Grounds, the Pomological Division, the Division of Agrostology, and the Seed Division, it may be remarked that the orange growers of California expressed their appreciation of Mr. Saunders's effort when they said the introduction of the Bahia or Washington navel orange had been worth more to the growers of California than the total cost of maintaining the Department of Agriculture since its inception.

It is the purpose of this bulletin to point out briefly some of the factors which should govern the work of plant introduction and to make clear, if possible, the new aspect revealed by recent progress in plant breeding and plant pathology.

The rapidly growing interest in the work of plant hybridization and selection and the increasing demands for species of plants to be used in the amelioration of those already in cultivation, open up new fields for legitimate plant introduction, while the recognition of the great losses caused by parasitic insects and fungi emphasize the importance of the most careful supervision and inspection of all imported plants.*

* The introduction of material for forest planting does not present all the problems which attend the introduction and improvement of fruits. Nor is it of the same importance or as full of promise. Moreover, the United States possesses in its forest flora such a wealth and variety of valuable species that there is little call for increasing the number, at least in the forest regions and for the present, when we have hardly yet begun to be acquainted with the possibilities of our own species and with the necessity of method in their propagation.

There is, to be sure, no objection even now to beginning the testing of exotics, for with a crop which matures in a century or so the results of such tests are long in coming, and hence a timely beginning is called for. If the German foresters had known what they will know within the next decade regarding our white pine and other conifers they would have used them more extensively than they did a hundred years ago. On the other hand, we should long ago have engaged in the planting of the cork oak for the sake of our growing wine industry, since through the importations by the Department some thirty years ago, and again through the Division of

PURPOSES OF PLANT INTRODUCTION.

THE ESTABLISHMENT OF NEW PLANT INDUSTRIES.

The first and most evident reason for the introduction of economic plants into any country, and that to which the ordinary mind at once refers, is the building up of new plant industries. To the most casual observer it must be apparent that the number of useful plants, compared with those of which man makes no use, is very small. The menu of an average American dinner includes the product of scarcely a dozen plants, and yet the number which could be grown for the table would reach into the hundreds. There are several reasons why the number of plants upon which we depend for subsistence remains small, and the competition between producers of the same plant product continues fierce, but the most potent one lies in a persistent conservatism of taste, which is both unreasoning and uncontrollable. That the German peasant should look upon Indian corn meal as fit only for his live stock,* or the inhabitants of some portions of Holland consider the sheep raised along their canals for the English market in the same light as Americans do horse flesh, are facts which must be reckoned with, however unreasonable they may appear, in any attempts at plant introduction. This conservatism in small matters, although often enough exhibited in America, is less firmly fixed upon us, as Sir Henry Norman and other European critics have pointed out. This is evidenced by our quick appreciation of such new fruits as the pomelo, or grape fruit, which has become almost as common with us as the orange,

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Forestry seven years ago, the adaptability of the species to our Southern States and California has been satisfactorily demonstrated.

As far as plant material for the arid regions is concerned, no expectation need be entertained that woods of high economic value will ever be grown in forests under the climatic conditions there prevailing. Arboriculture, not forestry, may be practiced in those regions for the sake of climatic amelioration, ornamentation, and comfort, and such species should be preferably chosen as produce abundant shade and perhaps useful fruit or some other advantages. Adaptation to climate—the possibility of growing under untoward conditions—is the first and most important consideration in choosing plant material for these regions. We possess trees in our own territory the possibility of utilizing which, under cultivation, is hardly yet tested. The mesquite, the China tree, the Osage orange, and other examples may be cited.

There is not so much difficulty in finding plant material as in finding incentive and enterprise to use it and knowledge of proper methods in its use.

Nevertheless there can be no doubt that our choice of really valuable plant material for these regions could be greatly extended by the systematic procedure outlined.—*B. E. Fernow.*

* Hock, F. Naehrpflanzen Mitteleuropas, 1890, Stuttgart, p. 44. Only 5 kilos per capita is produced, owing to unsuitable climate. According to the latest figures, as collected by Hitchcock (Bull. No. 10, Section of Foreign Markets, U. S. Dept. of Agriculture), the consumption of American corn in Europe must be rapidly increasing, as our exports of this grain increased from $37,836,862 worth in 1896 to $54,087,152 worth in 1897.

while in Sicily it has been cultivated for centuries, and is not even now appreciated as a table fruit. The growing favor of the persimmon, the increasing consumption of the banana, the established appreciation of the sweet potato, which is still practically an unknown vegetable in Covent Garden,* our fondness for the peanut and popcorn, as yet merely curiosities in Germany, indicate that such a state of stagnation is not yet reached as that of eastern Europe, at least, where even tomatoes are almost unknown and the sweet potato is one of the rarest and most costly of vegetables. On the other hand, the almost complete absence from American tables of the European artichoke (*Cynara scolymus*), something entirely different from the plant known by that name in America, which when properly grown is one of the most delicious of vegetables, indicates anything but a readiness to increase the list of available food plants.

According to Schübler, the artichoke has been cultivated in Norway as far north as the sixty-third parallel, and has long been grown in Louisiana and to a slight extent elsewhere in America. It is evident, accordingly, in this instance, as in many others, that the problem of building up a new plant industry is not merely to establish the fact that a desirable species can be successfully cultivated here, but it is equally necessary to bring the merits of the new product to public attention and thus create a market.

That such popular education in the use of food materials is legitimate work for a department of agriculture can scarcely be questioned, inasmuch as it fosters industries which without its aid could not well be built up. In order to introduce and establish a new-plant industry every assistance in the way of free seed or plants, full information regarding the methods of culture and care of the product, as well as aid in the creation of a market, should be furnished by the Department, and only when the industry is well on its feet should such support be withdrawn.

When it is recollected that the Irish potato, upon the cultivation of which millions depend for subsistence, was the discovery of an uncivilized race of Indians in the mountains of Chile, Peru, or Argentina,† and that even after these years of amelioration a variety has only recently been produced by careful breeding which yields per acre fourfold the amount of starch of any ordinary variety,‡ it can not but seem reasonable that the serious attention of civilized races will be able to discover and bring much more quickly into daily use fully as valuable food-producing plants as this tuber-bearing species of Solanum.

The development of the American varieties of grape and plum is an

*A market for this vegetable might be created in northern Europe if the proper steps were taken to bring it to the attention of the public.

†A. d. Candolle. Archives des sciences physiques et naturelles, III Ser., t. 15, 1886. Geneva. Quoted by Hock, l. c., p. 31.

‡Cimbals' new sort, Präsident Von Juncker. Swingle and Webber, U. S. Department of Agriculture Yearbook, 1897, p. 417.

example of discovery and improvement by a civilized race, and it can scarcely be doubted that the modern methods of extensive plant breeding will open the door for a rapidly increasing number of new food plants.

That such work has been done, is now being done, and is in contemplation by governments of foreign countries may be judged by the following brief accounts. To be sure, as quite pertinently pointed out by Mr. J. E. O'Connor, in an excellent article on the introduction of the carob tree in India,* the methods of introduction are not always properly chosen. He says:

> The article is first lauded as a most useful thing, and its acclimatization declared to be most desirable. Then there is a lull. A little later some official or perhaps some nonofficial gentleman, with a taste for these matters, sees the plant growing in some favorable locality, is struck with its appearance, introduces it with more or less success, and then leaves the district or the country, and the subject drops out of sight with him. A little later the whole process is gone through again, and so on *da capo*, the very slightest reference, if any, being made by each successive experimenter to the results of the trials made before his time. Thus the experiment, which might, if carefully watched, finally show in two or three years whether it was worth pursuing or not, drags on its weary course through thirty and forty years with indecisive results at last, and the moral of the story is, that such experiments should be carried out in suitable conditions under the close supervision of a central Government department, charged especially with such business and competent to undertake it.

The history of the introduction of cork oaks into the Southern States illustrates the need of continuity of experiments. In 1858 cork-oak acorns were secured and distributed by this Department throughout the Southern States and California, and from occasional trees still found scattered through the region it is evident that the plant will grow and thrive, but, owing to lack of early records and in the absence of reintroductions, no progress has been made toward the establishment of the cork industry. Corks in 1893 cost us $1,993,025, and undoubtedly cost us vastly more to-day, owing to the increasing production of wine. Over 3,488,000 acres are planted to cork oaks along the Mediterranean, and it is a comparatively recent industry there. It is not too much to suppose that Yankee ingenuity will some day eliminate the necessity for cheap labor in this culture, as it has by employing the McCormick reaper in the rice fields of Louisiana, and the United States will then be no longer dependent upon European nations for corks.†

The history of cinchona culture on the Island of Java, which small island now furnishes two-thirds of the quinine on the markets of the

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* O'Connor, J. E. The carob tree (*Ceratonia siliqua*) with reference to its cultivation in India. Notes on Products prepared in the Department of Revenue, Agriculture, and Commerce, 1811–1879, Calcutta, p. 66.

† Jones, J. D. Cork oak. Some Foreign Trees of Economic Value Adapted to Planting in the Southern States. Bull. 11, Division of Forestry, U. S. Department of Agriculture, 1895.

world, is an example of what government support of a plant industry has done. For thirty years the Dutch Government was urged to undertake the introduction of this valuable medicinal plant from Peru, and finally in 1852 the Dutch minister of colonies was authorized to employ the botanist Hasskarl, who explored the cinchona forests of Peru, bringing back twenty Wardian cases of different species of cinchona. Plantations of the various species were started and large sums of money expended, and although an error in the extensive propagation of a comparatively worthless variety, poor in the alkaloid, added unnecessary difficulty to the problem, the plantations, both governmental and private, now produce abundantly, and a factory is in operation on the island for the extraction and refinement of the product, which extraction has heretofore been done by European and American firms. The profit to the Government in 1896 from its plantations was $38,500, and over $11,395 worth of the refined product will be shipped to the United States alone this current year.*

The efforts of Clements R. Markham, engaged by the Indian government to introduce the cinchona culture into India, were crowned with success, and the cinchona plantations and factories of that region have assisted in the production of their share of the 600,000 pounds or more which are placed on the market annually. The price of the quinine is now so low† that it may be counted one of the inexpensive drugs, and this cheapening has been brought about by the introduction of the industry into India and Java.‡

The Colonial government of Cape Colony established in 1884 a government wine farm of 300 acres, with competent wine makers, for the purpose of stimulating the cultivation of the European grape and the building up of the wine industry. Imported pure selected yeasts have here been experimented with in the fermentation of the wine must and, although as yet apparently not with the success which attends their use in the Rhine region, a perceptible acceleration of the fermentation process and production of uniformity of product have been demonstrated. The government, by the introduction and propagation of resistant American vine stocks, which are sold for a nominal sum to grape growers, is encouraging the replanting of all vineyards with American stock, to prevent the catastrophe which the rapidly spreading ravages of the phylloxera are destined to produce.§

The Royal West Indian Commission, sent out by the British Government in 1896 to investigate the causes of agricultural depression in the British West Indies, recommended the expenditure of £17,000, or more

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*Everett, Sidney B. Quinine in Java. Consular reports LVIII, No. 217, Oct. 1898, pp. 266–267.

†(Nineteen to 19¼ cents per oz. in London.) According to de Indische Mercuur, No. 35, Aug. 27, 1898, p. 558, 9½d. to 9¾d. in London for sulphate of quinine.

‡Markham, Clements R. Travels in Peru and India. London, 1862.

§Wallace, Robert. Farming Industries of Cape Colony. London, King & Son, 1896, pp. 137, 139, 152.

than $81,000, annually for ten years, ostensibly for the purpose of establishing new plant industries in the islands. These grants were made by the last Parliament, and nine botanic stations on the various islands, with a head office in the Barbados, for the investigation of tropical agriculture and the introduction of economic plants will soon be established.* Dr. D. Morris, for some time assistant director of Kew Gardens, was appointed to take charge, and expects to begin the work of organization immediately. The botanic stations established some years ago in several of the islands have been the means of adding to the West Indian products, ginger, nutmeg, cloves, black pepper, guinea grass, sago, bourbon cane, coffee, mango, logwood, cinnamon, bamboo, camphor, orange, lemon, citron, yam, cacao, and shaddock, according to a recent article in Produce World.†

NEW VARIETIES OF PLANTS ALREADY IN CULTIVATION.

There is, however, another branch of the work which appeals more directly to the practical farmer and fruit grower—that of the discovery and introduction of new varieties of our cultivated plants. Such varieties may show superiority in any one of many qualities which will make them of great value to the cultivator and will be immediately appreciated by him.

The remarkable tendency of cultivated plants toward variation, which results in the production of innumerable varieties, is recognized as a factor of the utmost importance. The success or failure of a whole plant industry may depend upon obtaining a variety differing so slightly from others in cultivation that the ordinary observer would fail to detect a difference.

While the era of plant breeding upon which we are entering will undoubtedly result in the production of a preponderance of American varieties suited to American conditions, the fact remains that at present a large proportion of the best cultivated fruits, vegetables, and cereals grown in the United States are of foreign origination.

In the immense area—163,000,000 acres is the estimated wheat area‡—now devoted to the cultivation of our staple crops new varieties of great value are being constantly originated and tested, and it is the work of systematic plant introduction to match the conditions under which valuable varieties have proved successful abroad with areas in this country, and to introduce the desired plants and ascertain if any advantageous qualities are exhibited. There is no country in the world tilled

*Report of the West India Royal Commission, with subsidiary report by D. Morris, esq., D. S. C., C. M. G., assistant director of the Royal Gardens, Kew (Appendix A), and statistical tables and diagrams and a map (Appendix B), London, 1897, p. 70 and p. 150, Appendix A.

†The Produce World. R. H. Smart, editor, 11 Bells Building, Salisbury square, London, E. C. Sept. 2, 1898, Vol. III, No. 71, p. 856.

‡Annual address of Sir William Crookes before the British Association for the Advancement of Science, Bristol, 1898, p. 18.

by progressive cultivators whose connected territory presents such varied conditions of soil and climate as ours. The existence of regions in the United States whose cultural possibilities have as yet been only partially tested gives to the work of exploration a wide range, with reasonable hopes that each new territory explored will yield varieties more suited to some one at least of the numerous localities than those already in cultivation.

It is particularly in this branch of introduction work that the reputable seed and nursery firms of the country have rendered a most important service; plainly because a superior variety of a well-known plant possesses, immediately upon introduction, a market value which a new species may not. The fact must not be lost sight of, however, that to search out these new varieties and secure them requires the labor of trained explorers or specialists in the particular branches of plant industry. The chances of profitable return within a reasonable length of time are not such as to induce seed firms to undertake the work of exploration in the absence of laws protecting the importer of a new variety.

If the work of this character were left to individual enterprise, only occasional expeditions could be expected, and no comprehensive exploration of the cultivated territory of the globe would be undertaken. This branch of the work should in no way interfere with the interests of individual seed and nursery firms, since the quantities distributed must necessarily be barely large enough to call the attention of cultivators to the plants, and the demand which it would be the object of the experiments to create would have to be met by importations or propagations by the seed or nursery firms themselves.

THE COLLECTION OF SPECIES FOR BREEDING PURPOSES.

The work of plant introduction, when considered from the standpoint of the plant breeder, assumes a new and most important aspect. The Rev. Thomas Gulick,* whose papers upon evolution have attracted the attention of no less a biologist than Romanes, has pointed out the value of sexual sterility as a barrier which tends to prevent the obliteration of new characters developed by variation from a parent type. Should an individual plant showing most marked peculiarities distinguishing it from its progenitors be allowed to breed with other offspring from the same parents which show no such peculiarities, it would produce progeny more and more like the parent form, i. e., the peculiarity, be it ever so desirable, will be obliterated sooner or later by interbreeding. If, however, this peculiar offspring is more or less sterile to its immediate relatives, it will be prevented from interbreeding. Should its own pollen be prepotent, for example, to that from the parent stock,

* First clearly pointed out by Rev. John Thomas Gulick in his paper on Divergent Evolution through Cumulative Segregation, in Jour. Linn. Soc., Vol. XX, Zoology, p. 189, Dec. 15, 1887.

the beginning of a new race or variety would readily be conceivable. It is this factor of sexual sterility which must often be invoked to explain the continued existence, side by side, of closely related species.

If, on the other hand, the peculiar offspring shows no tendencies to sexual sterility toward its parents or near relatives, but is transported to some region which is separated from its home by a sufficient barrier, there will be no opportunity for interbreeding with the parent stock, and the new variety may be perpetuated.

Both of these forces, among others, are unquestionably at work in nature, and upon them certainly in part depends the origination of species and varieties. The breeder recognizes the importance of preventing the intercrossing of varieties which he has produced by carefully isolating individuals with especially desirable characters, and realizes how quickly a new variety will often be swamped if allowed to interbreed. Inbreeding is a recognition of this principle.

It will be evident from what has been said that in the former case two nearly related species developed side by side and prevented from interbreeding by sexual sterility* will be of comparatively little value for crossing purposes, while two species owing their origin to geographical segregation may be quite fertile toward each other, and will thus often prove of the greatest value in the production of new plant varieties or hybrids.

While the scope of this bulletin is too general to admit of a more detailed discussion of this most important phase of plant introduction in its relation to plant breeding, a few examples of its application may be cited to advantage.

Mr. Luther Burbank,† of Santa Rosa, Cal., in the origination of his remarkable hybrid blackberries and raspberries employed no less than 37 species of the genus Rubus, collected from all parts of the world. His "Japanese Golden Mayberry," the earliest raspberry known, ripening in California before strawberries, is the result of crosses between well-known American sorts, such as the Cuthbert and *Rubus palmatus*. This latter plant is described as an unproductive species with quite insignificant berries, and not at all palatable, while the raspberry-blackberry hybrid "Primus," remarkable for its early ripening, productiveness, and large size of fruit, was obtained by crossing the Western dewberry (*Rubus ursinus*) with a Siberian raspberry (*Rubus cratægifolius*).

The new breeds of cereals which have lately attracted considerable attention in England, the creations of J. & G. Garton, of Newton-le-Willows, have been produced by the employment of 7 different species, represented by over 350 varieties of wheat, 3 species or 100 varieties

* There are of course many other hindrances to interbreeding, such as difference in time of blooming, and differences of floral structure and coloration affecting the preferences of insect visitors.

† Burbank, Luther. New Creations in Fruits and Flowers. June, 1893, p. 23, Santa Rosa, Cal.

of oats, and 3 species or 70 varieties of barley, collected from Germany, France, Russia (one variety of Russian wheat, the Taganrog, proving especially valuable), Hungary, Greece, Italy, India, Australia, Japan, and North America.*

The small-grained naked oat (*Avena nuda*), introduced from China, has been crossed with Tartarian, Potato, and other varieties of the common oat and a variety of large-grained naked oat resulted, which Garton Bros. consider among their most valuable productions.†

The Phylloxera-resistant hybrid grape, Golden Clairette, which has attracted the attention of French vineyardists as possibly offering a simpler solution of that difficult problem than the use of American stocks, was a cross between the variety Aramon of the European grape *Vitis vinifera* and an American species *Vitis rupestris*.‡

The promising hybrids lately produced by Swingle and Webber between the hardy *Citrus trifoliata* and the ordinary orange, which may quite possibly extend northward materially the orange-growing belt of the Southern States, would not have been possible had not the former been introduced from Japan and established as a hardy ornamental.§

The introduction of the Chinese sand pear (*Pyrus sinensis*), in itself a purely ornamental species, bearing fruit that is scarcely edible, has resulted in the origination of the Kieffer and Le Conte varieties, which have revolutionized pear culture in the Southern United States.

The importance of assembling in gardens and arboreta throughout America collections of exotic species, particularly such as are related to those from which our cultivated plants have sprung, can hardly be overestimated; examples pointing to its desirability could be multiplied almost indefinitely. The work of plant breeding is, in fact, dependent in a measure upon the presence of such exotic plants. It is not meant by this to assemble such immense collections irrespective of their relationship with our cultivated crops as are represented by the great majority of botanic gardens of Europe. These have their place and should form a part of every university equipment, but are generally of little use to the plant breeder. The botanic garden is complete when it possesses one or two specimens of each species, but a garden for economic work should possess many species, secured from as many localities as possible, and a collection of varieties which may prove of more importance than the collection of different species.

To take a single example, the genus *Vaccinium*, which contains the ordinary cranberry and blueberry, still remains practically untouched

* McAlpine, A. N. Raising New Breeds of Cereals, in Trans. Highland and Agricultural Society of Scotland, Series 5, Vol. VI, 1894, pp. 145-148.

† Carruthers, William. Cross Fertilization of Cereals (Jour. Royal Ag. Soc. of England, Third Series, vol. 4, part IV, p. 701).

‡ Swingle, W. T., and Webber, H. J. Hybrids and their Utilization in Plant Breeding, in U. S. Department of Agriculture Yearbook, 1897, p. 398.

§ Swingle and Webber, l. c., p. 415.

by the plant breeder, and its species are scattered all over the world. Two species with refreshing berries are growing wild on the slopes of the volcanoes of Hawaii, *V. penduliflorum* Gaud., and *V. reticulatum* Smith. According to Ferd. von Mueller (Select Extra-tropical Plants), a species *V. arctostaphylos* L., with very palatable berries, occurs from Greece to the Caucasus. *V. grandiflorum* Dom., *V. bicolor* F. v. Mueller, and *V. alatum* Dom. grow in the cold zones of the Peruvian Andes and produce berries the size of a cherry, of an acidulous grateful taste. Southern India could furnish a species, *V. Leschenaultii* Wight, with cranberry-like fruits; the mountains of Mexico an arborescent species, *V. leucanthum* Chamisso; Jamaica a small-berried species, *V. meridionale* Swartz; while Madeira and the Azores possess an arborescent shrub, *V. padifolium* Smith, and the mountains of Colombia a second shrubby species, *V. mortinia* Benth., the fruits of which are marketed in Quito under the name of "Mortina." If such of these could be secured as were amenable to cultivation and acclimatization and gathered together with the dozen or more North American species, opportunities for the plant breeder would be afforded which could scarcely fail to result in the production of superlative blueberries, huckleberries, and cranberries, for which markets would easily be created.

A criticism that could be justly brought against the truly magnificent botanic gardens which the English, French, and Dutch Governments have scattered throughout their colonies and liberally supported, is that sufficient importance has not been attached to this work of the improvement of cultivated plants. Extensive collections of economic plants are to be found in many of these gardens, but apparently no attempt is made to establish, for example, specimens of all the species of coffee, which is the first step to be taken in the production of a better variety. Coffee is still grown from seed. There remains yet to be established a plant-breeding station in the Tropics, with which the work of systematic plant introduction can cooperate and gather together those food plants which it shall be the aim of plant breeders to utilize in producing superior varieties. As a move in the right direction the excellent work of Jenman and Harrison in British Guiana may be mentioned. Their results already obtained in the breeding of a superior quality of sugar cane stimulated the recommendation of a grant of $5,000 by the Royal West Indian Commission.* These English experimenters gathered 120 varieties of cane from various countries, and by crossing produced a cane with a higher percentage of sugar than ordinary cane—16.1 per cent as compared with 13.2 per cent for Bourbon cane, the variety hitherto grown in Guiana.

The finely equipped gardens of the Dutch in Java are modeled upon modern lines, and yet until recently no attempts have been made to

* Kew Bull. of Miscellaneous Information. Additional Series I, 1898. Report on the economic resources of the West Indies, by D. Morris, assistant director Royal Gardens, Kew, pp. 13 and 163.

breed up a better variety of coffee or to get together a collection of coffee species preparatory to such breeding work.*

METHODS OF PLANT INTRODUCTION.

COLLECTION OF THE PLANTS.

Through the agency of such institutions as are now maintained at Government expense in many of the most important capitals of Europe and in almost all of the European colonies, many valuable plants can be secured, but it would be a mistake to assume that an extensive collection of economic plants could be assembled from such sources, for in the great majority of cases, as above stated, these are not economic gardens, but rather institutions of instruction or public parks. The officers of such institutions are often not in position, nor do their tastes lead them, as a rule, to study the cultivated crops of the surrounding territory, and their knowledge of the practical value of different varieties is not such as would fit them for the selection of plants suited to our conditions. Their ignorance regarding conditions in America would further disqualify them to judge of the value of the varieties when introduced.

While the numerous important seed and nursery firms in foreign countries can be depended upon to furnish many interesting plants, the chances of obtaining from them really new and valuable varieties already generally cultivated in America are not great. On the other hand, they can be expected to assist materially in the introduction of plants designed to build up a totally new industry, since American firms will hardly venture to expend the large amounts of money necessary to put such an industry on its feet, as first attempts along new lines are seldom remunerative, owing to uncertainty of demand. There are, moreover, a host of smaller firms, especially in Europe, whose catalogues never reach this country, and who, nevertheless, offer for sale plants which are really novelties to America and worthy of introduction. A thorough study of the numerous nurseries and seed-growing establishments of foreign countries will reveal, furthermore, a number of most interesting plants introduced from all parts of the world which have not proven successful in Europe, but which, owing to our longer and hotter summers, may be expected to thrive somewhere in the United States.

Through the assistance furnished by our representatives abroad valuable aid can be secured, but until they are given the assistance of trained investigators, who understand the modern problems of agriculture and horticulture, too much reliance can not be placed upon this means of securing new and valuable plants. The work of hunting out such plants and the knowledge necessary to predict their value when

* De Indische Mercuur, August 28, 1898. Verslag 's Lands Plantentuin te Buitenzorg, Java, 1895, p. 34.

transplanted to American soil require special preparation. It is investigative work. Should the time come when agricultural attachés are located in foreign countries, their assistance and researches will lead without doubt to the securing of large numbers of new and valuable plants. In the absence of such foreign representatives, trained especially for agricultural work, the most economical method of securing new plants from foreign countries is to send trained explorers to find them and import them. Markham established in the British East Indies in one year, at the risk of his life, it is true, 9,732 cinchona trees (nine different species), which he had collected in the mountains of Peru. Seven years of governmental correspondence had failed to secure a single living plant.*

Fortune established the tea industry in India, but only at the expense of several years' collecting in the Chinese tea-growing regions.

Although it is now fifty years since Fortune made his explorations in China, and brought back with him the remarkable collections of new plants which made him famous, neither England nor America has seen fit to follow up these preliminary surveys which were so profitable. In response to a letter of inquiry regarding the methods which should be employed to secure new plants from this immense and as yet unexplored region Mr. Augustine Henry,† well known for his researches on the Chinese flora, says: "I would not waste money on postage. Send a man!"

Such collectors or agricultural explorers should preferably be trained agriculturists and horticulturists possessing the necessary practical experience which would enable them to judge of the value of varieties, and acquainted with the problems to be solved for such crops as it is hoped will be benefited by the introductions. They should, in addition, be plant pathologists, in order that the imported plants shall be free from such diseases and insects as are otherwise liable to be introduced, and a knowledge of what constitutes a weed would prevent the selection of such plants as show objectionable tendencies.

Too great stress can scarcely be placed upon these requirements, as a failure, for example, to be acquainted with the appearances and habits

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*Markham, Clements R. Travels in Peru and India. 1862, pp. 60-63, 491.

†Henry, Augustine, in a letter from Szemao par Laokay, Tonking, China, March 4, 1898, states: "The interior of China is one vast treasure of plants, useful, ornamental, and unknown. * * * It is curious that England could send out a Fortune fifty years ago, and that now the rich countries of Europe and the United States can't repeat that experiment of sending out a man. * * * Here (in Szemao) there is a Pyrus, with fruit as large as an apple, which is edible. It is most likely a very promising thing. There are four ovules in each locule, yet it is rather an apple than a quince. It is not a good fruit as it stands, but it has not been cultivated by the Chinese, and its possibilities are unknown. The Ribes and Rubus of the Hupei Mountains are very numerous in species, and I think of better flavor and actually larger than any cultivated ones I remember, yet they are all wild species. In Yunan and Sychnan, Rubus will be represented by 100 distinct species (50 are known), or perhaps more.

of disease-causing fungi and insects might lead to disastrous results. The introduction of the new corn mildew from Java might prove a curse to our cultivators. The banana disease of the Fiji Islands might possibly take the profits off banana growing in Porto Rico, while the three new insect and fungous diseases of the coffee plant that have lately been described from Guatemala, Réunion, and the Philippines should, by all means, be kept out of our new coffee-growing regions. Importations of plants from these regions could only be secured with safety under supervision of a trained plant pathologist equipped with proper apparatus for examination of all plants imported.

It must be realized that the specialization of our agriculture has already reached such a stage, resulting in such a host of plant varieties, that a knowledge of these various kinds sufficiently exact to be of great assistance in the selection of foreign varieties can not be acquired by a hasty study of any particular branch of plant industry. If plant introduction is to assist such highly developed industries, it will be by sending out experts to whom long experience has pointed out definite problems to be solved by the discovery of a variety superior to those already cultivated, or one possessing qualities which make it valuable for breeding purposes.

INSPECTION AND DISINFECTION OF PLANTS INTRODUCED.

The danger of inadvertently introducing new weeds, noxious insects, or dangerous parasitic fungi is one which should not be underestimated. This danger, however, can only be reduced to a minimum by narrowing the avenues of plant introduction and subjecting every importation to careful inspection and disinfection.

Although it is not necessary to alarm plant cultivators in the matter, particularly with reference to *carefully conducted* Government importations, it may not be unprofitable to refer to a few objectionable introductions as evidence of what importations carried on without proper inspection have brought with them.

The introduction of the San José scale is too recent to require more than a passing notice. It was introduced as late as 1870, probably from Japan, Australia, or Chile, a matter still in doubt, and in January of 1898, only twenty-eight years since its appearance, after having swept like a scourge over the country, it became the subject of imperial German edict prohibiting the importation of American fruits into Germany.*

The introduction of the coffee disease from Africa practically wiped out the Ceylon coffee industry; the damage done to European, South African, and South American vine-growing regions from the introduction of the phylloxera, downy mildew, and black rot has yet to be calculated; surely it would reach far into the hundreds of millions. It

* Howard, L. O. The San José Scale. Its occurrence in the United States, with a full account of its life history and the remedies to be used against it. Bull. No. 3, Div. of Entomology, U. S. Dept. of Agriculture, 1896. Howard, L. O. San José Scale in 1896–1897. Bull. No. 12, Div. of Entomology, U. S. Dept. of Agriculture, 1898.

has induced the passage of prohibitive import laws in most of the vine-growing regions of the world, which seriously hamper all private interchange of plant varieties. The water hyacinth that has stopped up the rivers of Florida, making navigation almost impossible, was an introduction of an apparently harmless ornamental plant. The briar rose since its introduction into Hawaii has become a most troublesome plant and the most serious weed of the Tropics; it is a species of the yellow-flowered *Lantana*, so ornamental a house plant in Europe. The prickly pear (*Opuntia ficus-indica*), highly prized as a fruit in Sicily, has proved a veritable curse in South Africa, causing, according to reliable accounts,* over a million dollars' loss annually. According to Halsted,† in his Preliminary List of the Weeds of Iowa, 18 out of 28 of the worst annuals, 3 out of the 6 worst biennials, and 7 out of the 17 worst perennials are foreign introductions. The Russian thistle introduced with flaxseed into Bonhomme County, S. Dak., in 1873–74, is now a more or less troublesome weed over parts of 35,000 square miles of farming land.‡

The fact that it is extremely difficult to foresee that a newly introduced plant will become a troublesome pest does not excuse the introduction of any plant whose propensities are already known. Such a step will not readily be excused by the practical farmer, who is constantly reminded of its disastrous results. The English sparrow has proved a serious nuisance wherever it has been introduced, and the English hare in Australia is a veritable curse.

In a recent bulletin§ by Dr. L. O. Howard, of the Entomological Division, the dangerous insects liable to be introduced into the United States from Mexico and Japan are described, and after such a survey nothing but gross carelessness would permit the introduction of such insects from these quarters.

The gypsy moth (*Porthetria dispar*), brought into New England with the idea of breeding up a new race of hardy silkworms at a time when the pébrine disease threatened to destroy the silk industry in France, although combated systematically almost since its first introduction, has cost over $775,000 in State appropriations, to say nothing of the losses which its ravages have caused.‖

It is desirable that such surveys be made, and the foreign diseases, both fungous and insect in nature, be called to the attention of those interested in introduction work. A knowledge of the areas infested with insects or fungous diseases would enable special quarantine regulations to be passed against those regions, such as have been adopted,

* Wallace, Robert. Farming Industries of Cape Colony. London, 1896, p. 90.

† Halsted, B. D. Bull. Bot. Dept. State Agricultural College, Ames, Iowa, 1888, p. 48.

‡ Dewey, L. H. Bull. 15, Div. Bot. U. S. Dept. of Agriculture, 1894.

§ Some Mexican and Japanese Injurious Insects liable to be Introduced into the United States. Bull. No. 4, Technical Series, Division of Entomology, U. S. Department of Agriculture, 1896.

‖ Howard, L. O. The Gypsy Moth in America. Bull. 11, new series, Division of Entomology, U. S. Department of Agriculture, 1897.